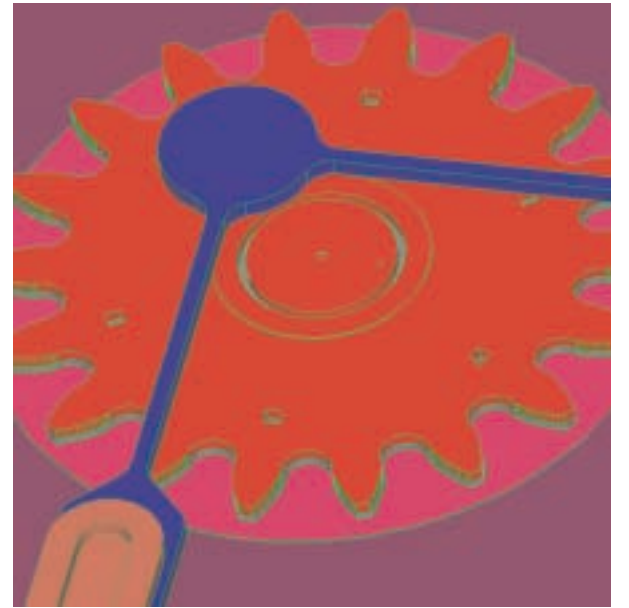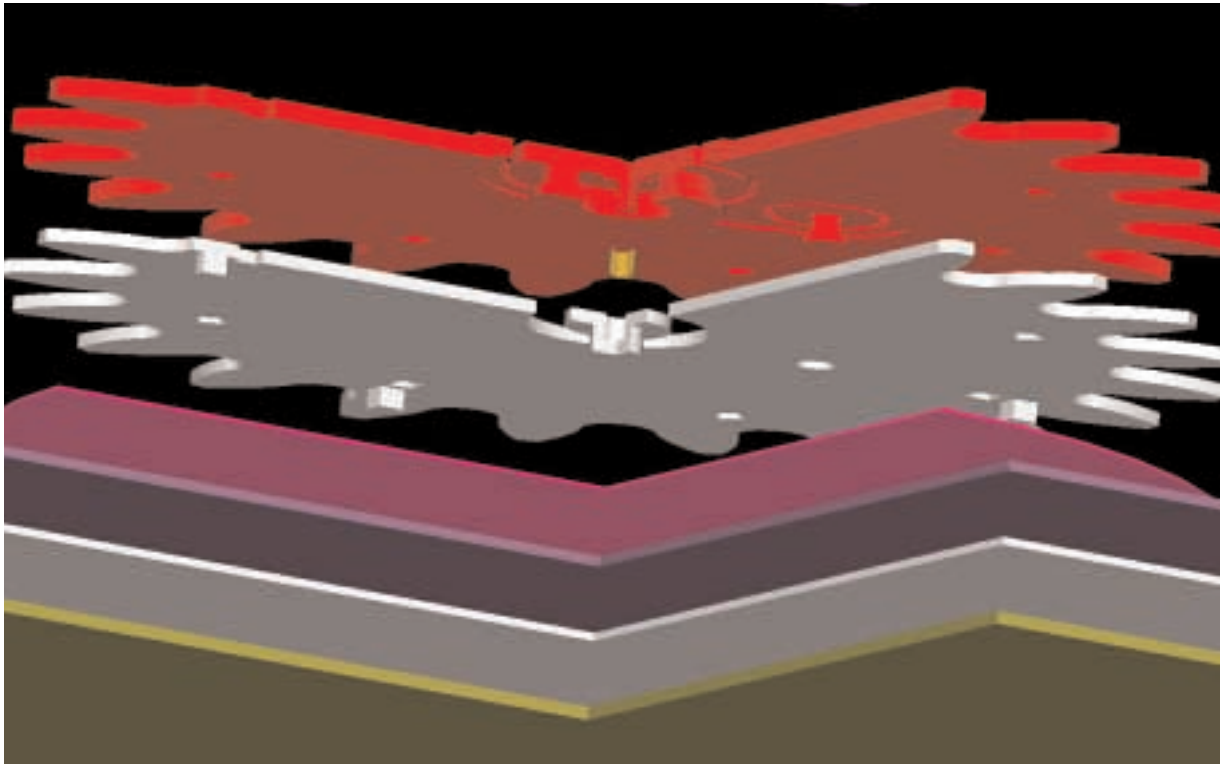# Sandia modelers make life easier for new MEMS designers

Previews do more than sell movies

Images generated by Sandia's
3-D MEMS modeling software designed by
Craig Jorgensen and Vic Yarberry

Story by Neal Singer

After months of hard work to design a prototype device, followed by the time and cost necessarily involved in fabricating it, designers of MEMS (microelectro-mechanical systems) often can be disheartened to learn their brainchild needs further modifications before it can be marketed as a workable device.

Such glitches occur because most researchers who design multilayered microdevices find it difficult to visualize how the micron-sized features of the etched layers fit together.

"It's not intuitive how the layers interact," says Craig Jorgensen (1769). "MEMS are wonderful in that they come out thousands at a time, all in one piece with no assembly necessary, but there's nothing simple about their design. You're building patterned layers on top of other patterned layers, which can create a complex 3-D geometry."

To make life easier for designers, Craig and Vic Yarberry (1737) have designed 2-D and 3-D modeling programs. Two-dimensional modeling shows the flat-plane cross sections of devices as they would look if fabricated. The 3-D version allows designers to twirl their virtual microdevices like airplane parts modeled in the macroworld, the still-imaginary part viewed from any perspective. Unworkable portions of the design can be modified or eliminated before — not after — fabrication work is paid for at the foundry.

The simulation process does take time. A simple microdevice can be simulated in seconds; a complicated one can take hours. Still, waiting for a computer to complete its complex modeling beats waiting months to find out what modifications one should have made.

"It's not easy for former macro-world designers to combine 2-D mask geometry with newly learned information about the MEMS fabrication process itself," says Vic, "and, on the first try, to create functional 3-D structures."

The previews, like a movie theater's "coming attractions," help designers choose the version they want to see in its entirety.

Marc Polosky (2614), who designs safety components in weapons systems, says the 2-D cross-sectioner enables him to visualize the effect of cuts in different thin film layers. Put simply, he says, "If you're making a gear on a pin joint, the program helps make sure you're not designing a gear that's rigidily fixed to the substrate and can't move." While the 2-D program is a valuable design tool that should help new designers get up to speed faster, Marc says, the 3-D modeler has potential of going to the next step — kinematic modeling — that will demonstrate these devices performing in environments.

Two papers by Vic and Craig on their modeling work were selected for presentation at the Fourth International Conference on Modeling and Simulation of Microsystems, held this spring at Hilton Head Island. The conference is the largest and probably most prestigious in providing an interdisciplinary forum for modeling, simulation, and scientific computing in the microelectronic, semiconductor, sensors, materials, and biotechnology fields.